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POSTEMBRYONIC DEVELOPMENT AND SYNONYMY FOR *EOSENTOMON ROSTRATUM* EWING (INSECTA-PROTURA)

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Abstract.—Durey, R. A., and T. P. Copeland, Department of Biology, East Tennessee State University, Johnson City, Tennessee 37601.—*Eosentomon pseudorostratum* Durey and Copeland is synonymized under *Eosentomon rostratum* Ewing. A reexamination of the type of *E. rostratum* reveals the presence of the foretarsal sensillum b′-1. The postembryonic development of *E. rostratum*, described and figured, conforms to the pattern for other *Eosentomon*. Statistical treatment of variation for characters used in the systematics indicates a high degree of reliability for most characters.

Ewing (1940) described *Eosentomon rostratum* from two specimens taken at Highlands, North Carolina. The type was redescribed by Bonet and Tuxen (1960), and by Tuxen (1964) giving characteristics of the tarsal sensillae and setae. The foretarsus was figured by them as lacking the sensillum b′-1.

Durey and Copeland (1968) described *Eosentomon pseudorostratum*, a second form of *Eosentomon* with piercing mouthparts. The description was based on 114 adults and 29 immatures taken on and in the vicinity of Mt. Mitchell, North Carolina, at altitudes ranging from 3,000–6,000 ft. All possessed the sensillum b′-1 which was unlike the description of *E. rostratum.*

Copeland had in his possession at that time several specimens collected in various localities of East Tennessee, but all at altitudes of less than 2,500 ft, which generally conformed to the descriptions and figures of *E. rostratum* including no b′-1 on the foretarsus. After examining the type, these were identified as *E. rostratum.* The forms from Mt. Mitchell had been compared to these and were different in that they always possessed the b′-1 on the foretarsus, and body size was larger.

Subsequent sampling at altitudes of less than 2,500 ft from over the Southeastern United States, ranging from Maryland to South Carolina and westward through Tennessee into Arkansas, yielded over 150 additional specimens of the form lacking the sensillum b′-1. None were collected possessing that sensillum.

The odd distributional patterns encountered suggested a reexamination of Ewing's type. This was done by Copeland and, as suspected, the type of *E. rostratum* (Fig. 1) was found to have the sensillum b′-1. That it

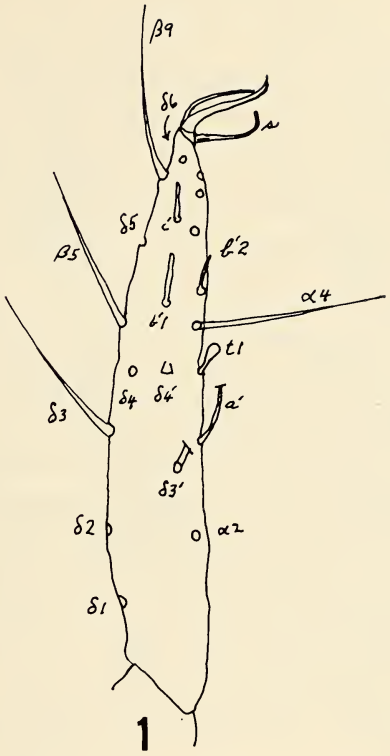
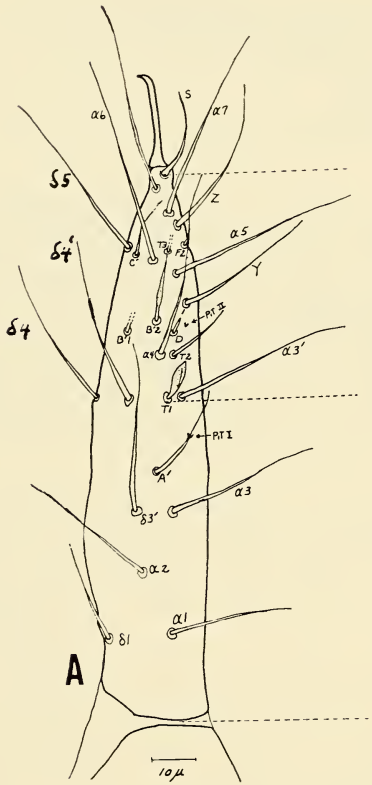


Fig. 1. *Eosentomon rostratum* Ewing. Holotype foretarsus.

had been overlooked previously by all is easily understood because of the condition of the type and the position of the one foretarsus present. In all respects *E. pseudorostratum* Durey and Copeland is identical to *E. rostratum* Ewing and must be synonymized.

Postembryonic Development of *E. rostratum*

Berlese (1909) discovered that Protura are unique among insects in adding segments with successive molts. Womersley (1927), Tuxen (1949, 1964), Condé (1961), Imadaté (1974 and in various papers), and one or two others have made significant contributions to knowledge of postembryonic development of several proturan species, but none of these are known to occur in the United States. Durey (1963) worked out much of the postembryonic development of *Eosentomon rostratum* Ewing (misidentifying the species as *Eosentomon pseudorostratum*) but he failed to publish it. Most of the following is condensed from his thesis.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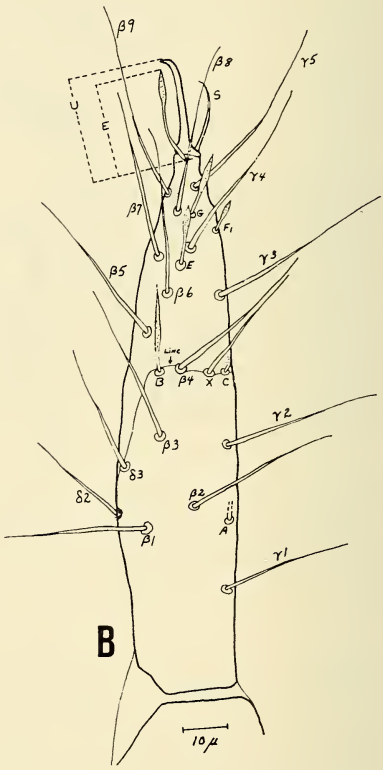
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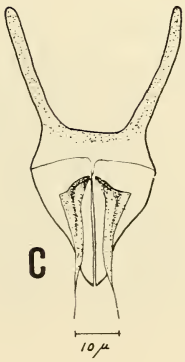
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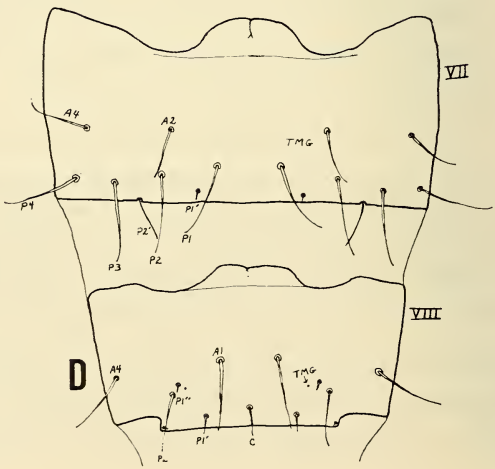
VII
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P1

Larva I.—General features of body resembling adult but with only nine abdominal segments, I–VIII and XII. Mouthparts, including peculiarly shaped mandibles, resembling those of adult and well sclerotized, but rest of body very poorly so. All tarsal sensillae and setae of adult present. Anterior setae on terga I–VII absent. Posterior row on tergum I with two primary, one accessory, and one microchaeta on each side; seta P 2′ not present. Sternum VIII with five posterior setae but no anterior ones. *Filamento de sostegno* glands in prothorax. Five dorsal and two lateral gland pores present in membranous region between penultimate and last segments. Ratios given made from averages of eight specimens: LR 3.4; PR 14.6; RS (Rostral Setae 3:1) 0.31; EU 0.9; TDP 0.87; and TR 5.4. In deriving the TDP the distal part of the tarsus was obtained by measuring from sensillum t-1 to the base of the claw and not to the base of the pretarsus as in the sense of Tuxen. Measurement to the base of the claw was made on all stages because it was thought this could be more accurately determined. A statistical analysis of variation was planned, and greater accuracy was of more importance than a strict adherence to the definition. Henceforth, we will use the BS of Condé as other authors now do.

Larva II.—In general appearance like larva I but with 10 abdominal segments, I–VII, X, and XII. Glands of *filamento de sostegno* in prothorax. Five dorsal and two lateral tergal gland pores present between segments VIII–X and two dorsal and two lateral pores between segments X–XII. The setae present occupy positions approximately the same as in the adult. Ratios averaged from five individuals: LR 3.3; PR 14.5; RS 0.32; EU 0.91; TR 6.1; TDP 0.74.

Maturus junior.—A 12-segmented form greatly resembling adult except not as well sclerotized. Segment IX formed between VIII and X, and XI proliferated from anterior part of XII. Thoracic and abdominal chaetotaxy identical to adult except four setae missing on sternum XI. Glands of *filamento de sostegno* in prothorax. Eight tergal gland pores between segments IX–X, four dorsally and four laterally; those between segments X–XI like those in larva II, 1-2-1. Genitalia absent. Ratios averaged from 16 individuals: LR 3.2; PR 15.3; RS 0.37; EU 0.9; TDP 0.71; TR 6.3.

Imago.—The redescription of the type by Bonet and Tuxen (1960) is applicable to the forms from Mt. Mitchell and will not be duplicated except for figuring certain structures. Because of its position the foretarsus of the holotype could not be adequately figured by Bonet and Tuxen—in fact, they could show only one side, as we can. For this reason, the

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Fig. 2. *Eosentomon rostratum.* Specimen from Mt. Mitchell. A–B, Foretarsus; C, Female genital apparatus; D, Terga VII–VIII.

Table 1. Chaetotaxy for four stages of *Eosentomon rostratum* Ewing.

Segment			Larva I	Larva II	New setae	Maturus junior	New setae	Adult	New setae
Th I	t		2	4	2[b]	4	–	4	–
	s		8	14	6	14	–	14	–
Th II	t	A	10	12	)4(c	12	–	12	–
		P	10	12	)2′(	14	)3′(	14	–
	s		8	14	6	14	–	14	–
Th III	t	A	8	12	4	12	–	12	–
		P	10	12	)2′(	14	)3′(	14	
	s		8	14	6	18	4	18	–
Abd I	t	A	0	0	–	4	)1,2(	4	–
		P	8	10	)2′(	10	–	10	
	s	A	4	4	–	4	–	4	–
		P	2	4	)2(	4	–	4	
Abd II	t	A	0	0	0	10	)1–5(d	10	–
		P	12	16	)2′,4′(	16	–	16	
	s	A	2	4	)2(	6	)3(	6	–
		P	4	4	–	4	–	4	
Abd III	t	A	0	4	)4,5(	10	)1–3(	10	–
		P	12	16	)2′,4′(	16	–	16	
	s	A	2	4	)2(	6	)3(	6	–
		P	4	4	–	4	–	4	
Abd IV	t	A	0	4	)4,5(	10	)1–3(	10	–
		P	12	16	)2′,4′(	16	–	16	
	s	A	2	4	)2(	6	)3(	6	–
		P	6	8	)4(	10	)3(	10	
Abd V	t	A	0	4	)4,5(	8	)1,2(	8	–
		P	12	16	)2′,4′(	16	–	16	
	s	A	2	4	)2(	6	)3(	6	–
		P	6	8	)4(	10	)3(	10	
Abd VI	t	A	0	4	)4,5(	8	)1,2(	8	–
		P	12	16	)2′,4′(	16	–	16	
	s	A	2	4	)2(	6	)3(	6	–
		P	6	8	)4(	10	)3(	10	
Abd VII	t	A	0	4	)4,5(	6	)2(	6	–
		P	12	16	)2′,4′(	16	–	16	
	s	A	2	4	)1(	6	)3(	6	–
		P	6	8	)4(	10	)3(	10	
Abd VIII	t	A	6	6	–	6	–	6	–
		P	7	9	)1″(	9	–	9	
	s	A	0	0	–	2	)1(	2	–
		P	5	7	)4(	7	–	7	
Abd IX	t					8	8	8	–
	s					4	4	4	–

Table 1. Continued.

Segment		Larva I	Larva II	New setae	Maturus junior	New setae	Adult	New setae
Abd X	t		8	8	8	–	8	–
	s		4	4	4	–	4	–
Abd XI	t				8	8	8	–
	s				4	4	8	4
Abd XII	t	9	9	–	9	–	9	–
	s	12	12	–	12	–	12	–

A. Anterior row.
P. Posterior row.
s. Sternum.
t. Tergum.
[b] Setae not numbered, total number of setae.
[c])4(indicates seta a 4 added on each side.
[d] a 1, 2, 3, 4, 5, added on each side.

foretarsus of a form from Mt. Mitchell is presented as Fig. 2, A–B. The sensillum b′-1 occupies a peculiar postion in that it is distal to the seta delta 4′ and not proximal to it as in other *Eosentomon* species. The female genital apparatus of the same specimen from Mt. Mitchell is shown as Fig. 2, C. On the holotype this structure cannot be seen clearly. Positions of the setae and sensillae on terga VII–VIII are illustrated by Fig. 2, D. They are the same on the holotype. Glands of *filamento de sostegno* in prothorax. Ratios averaged from approximately 100 individuals: LR 3.1; PR 13.2; RS 0.43; EU 9.3; TR 6.3; TDP 0.70.

Discussion

In the 114 adults, 8 larvae I, 5 larvae II, and 16 maturus junior there were no variations in: (a) presence of very long labrum and stylet-shaped mandibles; (b) presence of sensillum b′-1 on the foretarsus; (c) absence of club on pretarsal sensillum s; (d) setae (sensillae) P 1′ on tergum VII short, peglike, and inserted along the posterior margin of the sclerite; and (e) glands of the *filamento de sostegno* in the prothorax as they are in the type of *E. rostratum*. The chaetotaxy for each stage and the setae added in each are shown in Table 1. Prelarva and preimago stages not found.

Twenty-six of the adults had discrepancies in setae, but every case was an obvious asymmetry because it involved the addition or loss of a single setae from only one side of the segment. The holotype also has nine setae in the anterior row on tergum VI instead of the usual eight.

Several body structures and ratios used in the descriptions of Protura were measured and treated statistically to check their variation in this population. In some specimens the limits of certain of these structures

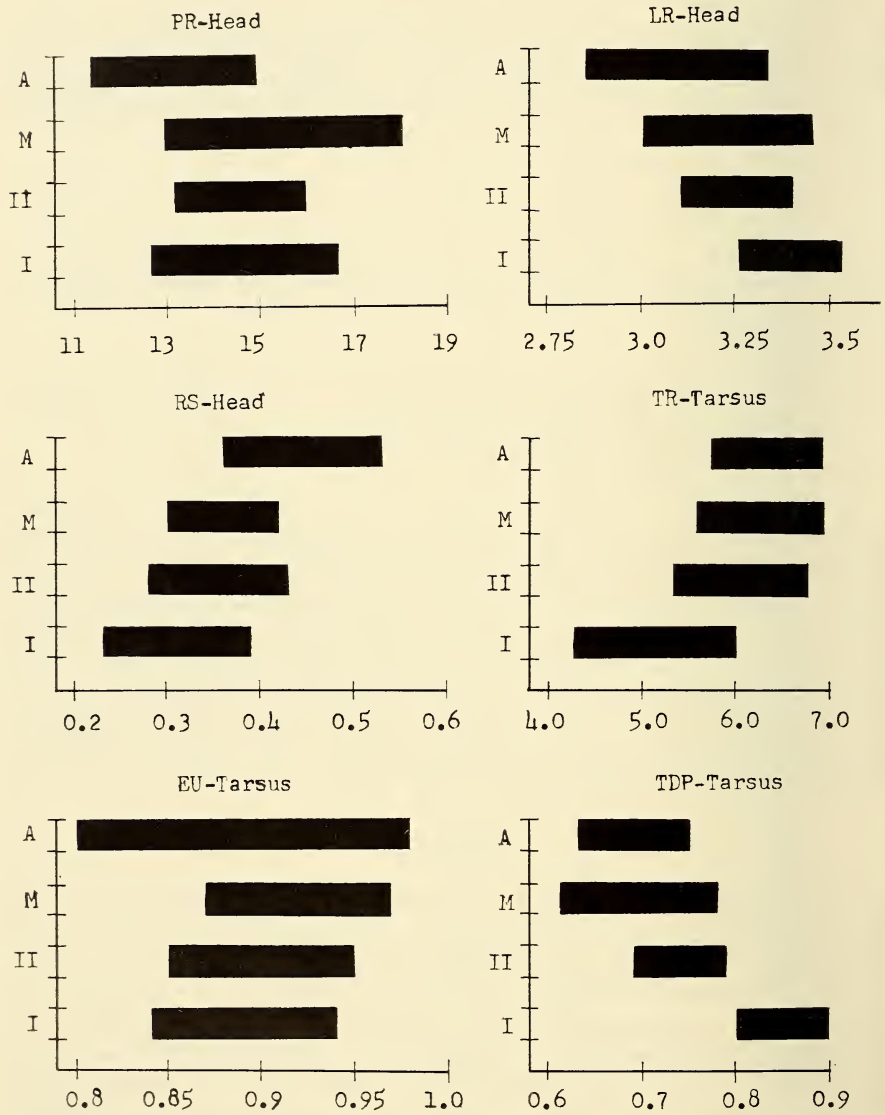

Fig. 3. Comparison of the six ratios PR, LR, TS, TR, EU and TDP among four stages of *Eosentomon rostratum*. A, Adult; M, Maturus junior; II, Larva II; I, Larva I.

could not be determined, and these were not included in the calculations. The median, standard deviation from the mean and standard error of the mean were calculated on the basis of the number of characters measured. The results are shown in Table 2. Lengths and ratios of the head and

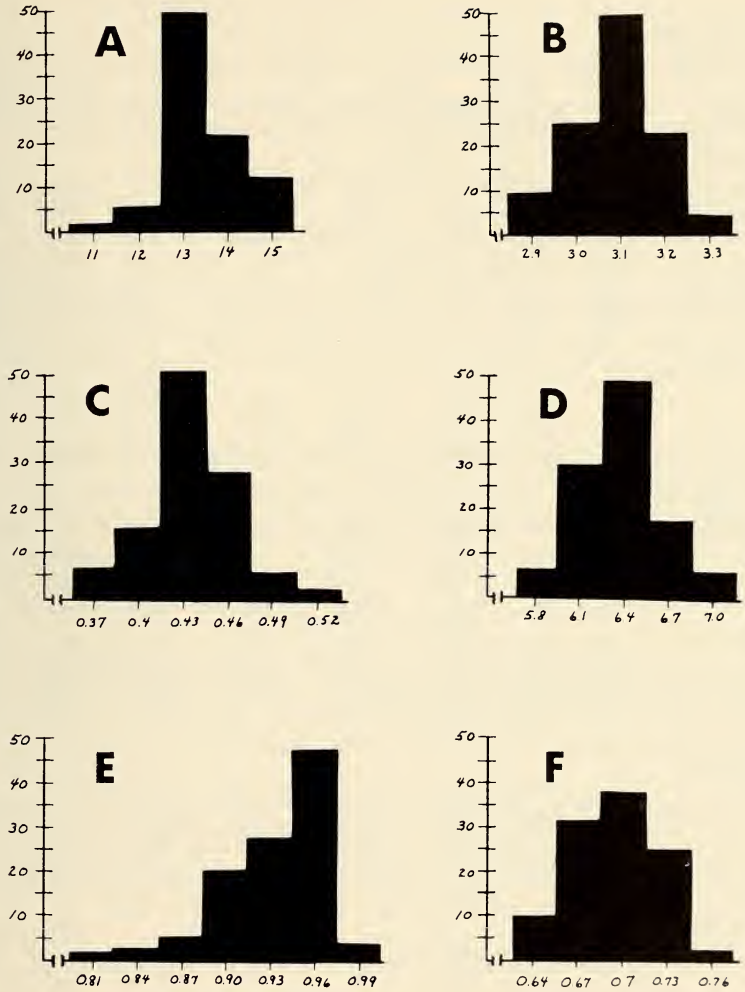

Fig. 4. Frequency distribution of six ratios for adult *Eosentomon rostratum*. A, Pseudocular ratio (PR); B, Labral ratio (LR); C, Rostral setae 3:1 ratio (RS); D, Tarsal ratio (TR); E, Empodium-unguis ratio (EU); F, Total distal proximal ratio (TDP).

tarsus appear to be less variable than lengths and ratios of setae and sensillae. The more variable nature of seta and sensillae may be more apparent than real because errors in measurement of the smaller structures has greater influence on the results obtained. The data indicate that of the foretarsal sensillae, t-1, e, g, and f-1 show the least variation in length, but this may also be due to the greater difficulty in seeing and accurately measuring the others.

Table 2. Variation in lengths and ratios of certain structures of adult *Eosentomon rostratum* Ewing.

Structure*		No.	Min.	Max.	Range	Median	Std. dev.	Std. error
Head lengths								
Capsule	H	107	150.	169.2	19.2	156.8	4.1	0.395
Labrum	L	111	46.8	56.4	9.6	50.9	1.78	0.168
Ratio	LR	107	2.85	3.34	0.49	3.10	0.10	0.010
Total	TL	107	198.	222.	24.	207.73	4.06	0.488
Pseudoculus	P	89	10.8	14.4	3.6	11.92	0.62	0.065
Ratio	PR	88	11.4	15.	3.6	13.18	0.78	0.083
Rostral setae								
RS	III	102	18.	30.	12.	22.68	1.84	0.182
RS	I	110	48.	70.8	22.8	52.12	2.71	0.258
Ratio RS	III/I	104	0.36	0.53	0.17	0.43	0.03	0.003
Tarsal lengths								
Empodium	E	106	14.56	20.8	6.24	18.89	1.01	0.098
Unguis	U	107	18.2	22.36	4.16	20.42	0.82	0.079
Ratio	EU	106	0.80	0.98	0.18	0.93	0.04	0.004
Distal	TD	108	48.	58.8	10.8	53.35	1.86	0.179
Proximal	P	110	70.8	81.6	10.8	76.08	2.44	0.232
Ratio	TDP	108	0.63	0.75	0.12	0.70	0.03	0.003
Total	TL	108	122.4	138.	15.6	128.77	3.50	0.336
Ratio	TR	104	5.71	6.92	1.21	6.35	0.26	0.026
Mesonotum								
Setae	p 1	107	33.6	44.4	10.8	37.02	2.04	0.197
	p 1′	106	34.8	44.4	9.6	37.8	2.21	0.214
	a 1	74	18.	26.4	8.4	22.14	1.86	0.216
	a 2	71	36.	48.	12.	41.9	2.62	0.311
Abd. tergum IV								
Setae	p 1	109	32.4	42.	9.61	36.44	1.98	0.190
	p 1′	103	27.6	36.	8.4	31.28	2.01	0.198
Tarsal sensilla	t 1	109	7.8	11.96	4.16	9.66	0.74	0.070
	t 2	109	13.	19.76	6.76	16.28	1.48	0.141
	t 3	24	5.2	9.88	4.68	7.02	1.15	0.236
	a′	109	15.6	24.44	8.84	20.89	1.53	0.147
	b′ 1	19	7.81	17.68	9.88	14.04	2.77	0.634
	b′ 2	102	10.92	20.8	9.88	15.6	2.01	0.199
	c′	18	7.8	18.2	10.4	12.48	2.54	0.780
	X	109	25.56	37.44	9.88	33.88	1.97	0.189
	Y	108	28.08	38.48	10.4	33.54	1.67	0.161
	Z	105	31.2	40.56	9.36	35.94	1.77	0.173
	a	29	10.4	16.64	6.24	13.03	1.87	0.348
	b	109	15.6	24.44	8.84	19.88	1.44	0.137
	c	42	7.8	18.72	10.92	13.	3.09	0.420

Table 2. Continued.

Structure*		No.	Min.	Max.	Range	Median	Std. dev.	Std. error
	d	45	6.24	16.12	9.88	8.71	2.75	0.410
	e	104	11.44	17.68	6.24	13.44	0.95	0.093
	g	109	11.96	16.64	4.68	14.07	1.0	0.096
	f 1	99	7.8	13.	5.2	10.11	0.96	0.097
	f 2	22	7.28	11.44	4.16	10.2	1.05	0.225
	s	101	14.56	22.36	7.8	19.02	1.4	0.139
Distance	a′–t 1	107	13.	18.2	5.2	15.63	0.94	0.091
Distance	a′–t 2	106	22.88	29.64	6.76	25.92	1.19	0.115
Distance	t 1–t 2	107	7.28	11.44	4.16	10.27	0.74	0.071

* Lengths in microns.

The ratios PR, LR, RS, TR, EU, and TDP for the four stages are compared in Fig. 3 and their frequency distributions in Fig. 4. Because of the small sample size, it is felt that only trends are indicated for each of the three immature stages.

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